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# Design, Development, and Flight Test of a Demonstration Advanced Avionics System

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National Aeronautics and  
Space Administration

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## DESIGN, DEVELOPMENT, AND FLIGHT TEST OF A DEMONSTRATION ADVANCED AVIONICS SYSTEM

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### SUMMARY

Ames Research Center initiated a program in 1975 to provide the critical information required for the design of integrated avionics suitable for general aviation. The program has emphasized the use of data busing, distributed microprocessors, shared electronic displays and data entry devices, and improved functional capability. Design considerations have included cost, reliability, maintainability, and modularity. As a final step, a demonstration advanced avionics system (DAAS) was designed, built, and flight tested in a Cessna 402, twin-engine, general-aviation aircraft. The purpose of this paper is to provide a functional description of the DAAS, including a description of the system architecture, and to briefly review the program and flight-test results.

### 1. INTRODUCTION

During the 1970s, increasing demands were made of the general-aviation pilot. Operating procedures were becoming more complicated, regulations were more restrictive, and the demands of the National Airspace System were increasing. During this same period, the general-aviation avionics industry aggressively applied new technology to meet these requirements at affordable prices. However, these developments were along traditional lines with integration occurring only in a few specific areas, such as navigation/communication systems and integrated flight director/autopilot designs. Using this approach of limited integration, the addition of more sophisticated capabilities, such as a performance computer, an intelligent monitoring and warning system, or a ground-proximity warning system, becomes expensive and cumbersome because of the need for separate displays and controls and for signals from aircraft sensors that either do not have an appropriate output or are not easily accessible.

Recognizing this problem, the National Aeronautics and Space Administration initiated a program in 1975 to determine the feasibility of developing an integrated avionics system suitable for general aviation in the mid-1980s and beyond. The objective was to provide information required for the design of reliable integrated avionics that would enhance the utility and safety of general aviation at a cost commensurate with the general-aviation market. The program has emphasized the use of data busing, microprocessors, electronic displays and data entry devices, and improved functional capabilities.

As a final step, in August 1978 a contract was awarded to Honeywell, Inc., teamed with King Radio Corp., for the design and analysis of a projected advanced avionics system (PAAS) concept, and the fabrication and installation of a demonstration advanced avionics system (DAAS), which was capable of demonstrating the most critical elements of PAAS, into a NASA-owned Cessna 402B, twin-engine general-aviation aircraft. The general requirements for DAAS were that it demonstrate the feasibility of designing an integrated system that would provide the pilot with an improved capability and that would be modular, reliable, and easy to maintain. The DAAS acceptance flights were conducted at Olathe, Kansas, in June 1981, and an operational evaluation by more than 100 evaluation pilots and observers, representing all segments of the general-aviation community, was completed in May 1982.

An overview of the program with a summary of the results that led to the DAAS specification is contained in Denery et al. (1978). A preliminary functional description of DAAS is provided in Denery et al. (1979), and a detailed description of both PAAS and DAAS is provided in Honeywell, Inc., and King Radio Corp. (1982a, 1982b). Preliminary results of the flight test are contained in Hardy et al. (1982), and a complete analysis of the flight-test results will be published later this year. The purpose of this paper is to summarize the basic features of DAAS in its final configuration and to address briefly the reliability, maintainability, and pilot acceptability of the DAAS concept based on flight experience.

### 2. PILOT/SYSTEM INTERFACE DESIGN GUIDELINES

The DAAS pilot/system interface was designed to provide a high degree of flexibility and capability while minimizing operational complexity. The primary interface between DAAS and the pilot is achieved through an electronic horizontal situation indicator (EHSI), an integrated data control center (IDCC), an assortment of function- and mode-select buttons, and a two-axis slew control (Fig. 1). A more complete description of the instrument panel and associated displays and controls is contained in Sec. 4. Specific design guidelines included (1) commonality of electronic display formats for the various DAAS functions; (2) parallel access to all the system capabilities or functions (parallel access means that the pilot can exercise any of the system functions directly without being required to have first performed other functions in an ordered sequence); (3) minimization of the requirement for the pilot to change the displayed information during a normal flight; and (4) designing DAAS to be a source of pilot information but not a decision maker.

To demonstrate these features, DAAS was designed to include (1) an automated guidance and navigation capability, using VOR/DME navigational facilities; (2) standard flight control with navigation coupling; (3) a flight status function; (4) computer-assisted handbook computations such as weight and balance and performance; (5) a monitoring and warning system for alerting the pilot to aircraft mismanagement and engine anomalies; (6) storage of normal and emergency checklists and operational limitations; (7) a data-link capability using the discrete address beacon system (DABS) or Mode S transponder (the FAA-proposed replacement for the ATRCBS transponder); (8) maintenance assistance; and (9) a simulation mode for pilot training and familiarization. These capabilities are described in greater detail below.



### 3. FUNCTIONAL CAPABILITIES

**Guidance and Navigation:** The DAAS provides for (1) standard ILS/localizer and VOR/DME navigation; (2) area and vertical navigation with respect to an arbitrary waypoint; and (3) area and vertical navigation with respect to a predefined flightpath specified by a sequence of linked or connected waypoints. The DAAS allows a combination of up to 10 of any of the above waypoints to be stored in nonvolatile memory. In addition, the frequency, station identifier, magnetic variation, elevation, and latitude and longitude for up to ten navigation stations can be stored. The system is mechanized so these navigation facility data can be used to reduce the data entry required for defining specific waypoints.

The area- and vertical-navigation capability is representative of current-generation systems. The measurements from a single VOR/DME are blended with true airspeed, heading, and barometric altitude to provide an improved signal. In addition, the VOR and DME Morse code identifiers are decoded and correlated with the desired station identifier for positive station identification. The navigation outputs include ground speed, ground track, winds, and aircraft position with respect to the selected flightpath.

**Flight Control:** The flight-director/autopilot is a digital implementation of the King KFC 200 autopilot modified to make it compatible with the DAAS navigation system. The autopilot modes include yaw-damper, heading-select, altitude-hold, altitude-arm, vertical-navigation, navigation-arm, navigation-coupled; approach-arm, and approach-coupled. If the autopilot is coupled to the area-navigation function, the autopilot provides (upon pilot request) automatic transitioning between waypoint inbound and outbound courses.

**Flight Status:** A GMT clock and fuel totalizer capability is provided; together with the area-navigation capability described above it is used to provide the pilot with a complete assessment of his status. Included are continuous computations of (1) GMT time, ground speed, winds, power setting, and fuel remaining; (2) the distance and time required to reach each waypoint in a predefined sequence of waypoints; and (3) the estimated time of arrival and fuel remaining at each of these waypoints.

**Computer-Assisted Handbook Computations:** The DAAS provides a capability for assisting the pilot in rapid computations of (1) weight and balance, (2) takeoff performance, and (3) cruise performance. Inputs to the weight and balance calculations, such as fuel load and passenger weight, are entered manually. The DAAS then computes the center of gravity and gross weight and alerts the pilot if the computed values are out of the allowable range. Inputs to the performance calculation can be performed by manual data entry or automatic entry of sensor data such as manifold pressure (MAP), engine rpm, outside air temperature (OAT), barometric altitude, winds, and aircraft weight (using the fuel totalizer function) that may be available in DAAS at the time of the computation. The DAAS then provides estimates of the fuel burn rate, mileage per unit of fuel burned, percent power, true airspeed, and ground speed.

**Monitoring and Warning:** A significant contribution of an integrated avionics system is its ability to correlate the measurements from different sources and alert the pilot to abnormal or unsafe conditions. To demonstrate this concept DAAS includes an engine-monitoring function, an aircraft-configuration-monitoring function, and a ground-proximity warning function.

The engine-monitoring function provides continuous monitoring of manifold pressure and engine rpm. The aircraft-configuration-monitoring system continually monitors the position of the doors, landing gear, cowl flaps, wing flaps, auxiliary fuel pumps, and trim as a function of aircraft state. In both cases the pilot is alerted to out-of-tolerance conditions.

The ground-proximity warning function is based on Mode 1, defined in ARINC Specification 594-1; it alerts the pilot to excessive rates of descent with respect to the terrain.

**Normal and Emergency Checklists and Operating Limitations:** The normal and emergency checklists and operational limitations are stored in DAAS so that the pilot can quickly and easily refer to them.

**Data Link:** The ATC communication, weather, reporting, ATC test messages, or weather information at destination can be communicated to the pilot via the transponder data link and displayed on an electronic display. Future plans call for exercising this capability at the FAA Technical Center in Atlantic City, N.J., with the test ground system. In order to introduce the demonstration pilots to the capabilities of DABS, certain of its features are simulated in the DAAS.

**Maintenance Assistance:** The DAAS includes built-in test (BIT) to assist maintenance and fault isolation. The BIT is designed to facilitate demonstration of avionics testing in the context of projected advanced general-aviation maintenance concepts that would exist in PAAS. The DAAS also includes an automatic functional-test/fault-localization at powerup or when commanded by the operator, which identifies failed line-replacement units, and an interactive functional test capability which allows the testing of devices when operator actions or observations are necessary to complete a test. For example, electronic display test patterns are included in DAAS to demonstrate interactive testing.

**Simulation Mode:** By selecting the simulation mode, the DAAS can be exercised on the ground for pilot training. The pilot controls the simulated aircraft through the autopilot mode-select panel. All DAAS displays, controls, and functions can be demonstrated in the simulation mode.

### 4. DAAS DISPLAYS AND CONTROLS

The DAAS instrument panel is shown in Fig. 1. The DAAS comprises all the instruments on the left side of the panel, the engine instruments, the integrated data control center (IDCC), and the radios located in the center of the panel. The two electronic displays are an electronic horizontal situation indicator (EHSI) and the IDCC. The EHSI provides a function similar to that of an electromechanical HSI but also serves as an electronic map. The IDCC display is used for alphanumeric messages and is the primary means by which the pilot communicates with DAAS. The EHSI and IDCC are discussed in greater detail later in this



section. The other instruments are already used in general aviation; based on earlier configuration studies (Denery et al., 1978), the replacement of these instruments with electronic displays would be costly in the demonstration program and would not substantially affect the program objectives. Because DAAS is a research system, the right side of the panel is provided with a set of independent conventional instruments for use by a safety pilot.

**EHSI:** The EHSI used in DAAS is a 4.5- by 4.5-in. monochromatic CRT raster scan display. It has two formats. One, which is activated when the VOR or ILS navigation mode is selected, provides angular deviation from the desired course in much the same manner as contemporary horizontal situation displays. The other, which is activated when an area-navigation mode is selected, provides a moving-map presentation. The scaling choices for the moving-map presentation include terminal area, 2 n. mi./in.; en route, 8 n. mi./in.; and a 40 n. mi./in. scale to assist the pilot in overall flight planning.

The EHSI, with a moving-map presentation and EHSI controls, is illustrated in Fig. 2. Most of the symbols are self-explanatory. The scale across the top of the display with the "270" digital readout gives aircraft heading. The selected heading is indicated by the heading-select bug on the heading scale and the digital and graphical presentation in the upper left portion of the display. Radio altitude is displayed in the upper right-hand corner when the aircraft is lower than 2,500 ft above the ground. Data pertinent to the active waypoint are shown along the left side of the display. These data include the minimum descent altitude or decision height if the waypoint is an approach waypoint; the active waypoint number; the course, distance, and time to or time from the active waypoint; the waypoint altitude (which is used for both altitude select and vertical navigation); and the VOR/DME receiver being used for navigation. The numeral "1" below the indicated course (CRS 295) indicates that the aircraft is on the inbound course; an outbound course would be indicated by the numeral "2." The WP AVAIL display on the lower right side alerts the pilot when the navigation station associated with the next waypoint is received, based on a periodic scan of the frequency by the DAAS radios. The VTA scale along the right side of the display is used to show the vertical angle between the current aircraft position and the next waypoint. When the vertical navigation mode is engaged, the actual deviation from the derived vertical path is shown on the electromechanical attitude director indicator. The wind magnitude and direction are depicted on the lower right portion of the display. The dashed line projecting from the aircraft symbol indicates projected ground track. Also shown are symbols for the waypoints, the courses connecting sequential waypoints, and navigation facilities within the range of the display.

The controls for the EHSI, which are located adjacent to the display, include a two-axis slew control and EHSI function keys. The slew control is used to (1) slew the map presentation laterally or longitudinally so that the pilot can review the predefined flightpath beyond the normal range of the display or (2) control a cursor on the EHSI display for graphically defining waypoint coordinates. The function keys allow the operator to (1) select a heading-up or north-up map presentation (HDG/NOR); (2) designate whether the slew control is used for slewing the map presentation or controlling a cursor for graphic definition of waypoint coordinates (MAP/CRSR); (3) automatically recenter the map if it has been slewed from the normal position (MAP RTN); (4) add or delete the presentation of an active waypoint bearing needle from the display (WP BRG); (5) review the planned flight, using the map-slew feature during preflight when radio signals are not available (REVU); and (6) select the map scaling (2 NM, 8 NM, 40 NM).

**IDCC:** The IDCC is shown in Fig. 3. The cathode ray tube is identical to that used in the EHSI display. The display format provides 16 lines of 32 characters. The two bottom lines are reserved for scratch pad, warning messages from the monitoring and warning system, and error messages resulting from invalid data entries. The two top lines are reserved for the title of the selected IDCC display presentation. The remaining portion of the display provides two columns, each with four data entry or selection commands; these commands are activated by the pilot, using the bezel keys along the edges of the display.

The IDCC also contains a set of dedicated function keys along the top. These keys are used to call up specific pages on the IDCC display (PAGE SELECT) or to execute specific functions associated with the DAAS navigation capability (NAV), which include activating the selected waypoint on the IDCC display (USE); activating automatic course change between inbound and outbound courses (AUTO CRS SEQ); manual selection between inbound or outbound course (CRS SEL); and automatic generation of an inbound course from the aircraft present position to the active waypoint (LAT DIR TO).

The keys at the bottom left of the IDCC are used for data entry. A telephone-type keyboard format with three letters on each key is used for alphanumeric entries. The alpha ambiguity, which results from having three letters on each key, is resolved by touching one of the three buttons along the bottom of the keyboard (Fig. 3), thus designating the left, middle, or right letter in a group. A toggle is located to the right of the keyboard for rapid change in the displayed information from one page to another, if a sequence of pages is involved in a particular function.

Figure 4 shows an example of an IDCC display format. This display is presented for the waypoint which is currently being used for navigation when the WP DATA key at the top of the IDCC is pressed. This is referred to as the active waypoint. Waypoint 1 is presented as the active waypoint when the system is first turned on. The label at the top of the display, "WP DATA P 1 of 10," identifies the page. The subtitles adjacent to the asterisks identify the function of the eight bezel keys. Two types of bezel key function entries are illustrated on this page: alphanumeric data entry (first column and first two entries in the second column) and mode select. To enter alphanumeric data, the pilot predesignates the parameter to be changed by touching the key alongside the appropriate subtitle, keying in the desired data, reviewing them in the scratch-pad portion of the IDCC display, and, upon approval, touching the enter key (ENTR) on the IDCC. Upon touching the bezel key alongside the appropriate title, an arrow appears to the left of the quantity to be changed. When two data entries are associated with a single key, such as the frequency (FREQ) and station elevation (ELEV), the arrow can be advanced from FREQ to ELEV by touching the bezel key a second time or by touching ENTR. As mentioned above, on touching ENTR, the quantity in the scratch pad will be entered into the location designated by the arrow. If the scratch pad is clear, the arrow is advanced without altering the stored value. An example of the mode-select function is provided by the MDA OR DH or NAV MODE subtitles. By using the appropriate bezel key, the pilot has the option of (1) designating the waypoint as being an MDA or DH waypoint or (2) navigating in a VOR/ILS mode (VOR/ILS) as opposed



to an area-navigation mode (RNAV). The selected mode is indicated by the > symbol which is toggled between the two choices by sequential pressing of the bezel key.

In order to minimize data entry, DAAS automatically enters data where possible. As an example, assume that a waypoint is referenced to a navigation station whose data have been previously stored by using the NAV AID DATA page. Then, on entering the navigation station reference number (NAVAID NO), the prestored station identification (ID) and frequency and elevation (FREQ/ELEV) are automatically entered on the waypoint data page. In addition, if a sequence of the waypoints is entered and referenced to previously stored navigation station data, the DAAS assumes these waypoints are connected, and the DAAS-computed inbound and outbound courses (CRS1/CRS2) are automatically entered. The pilot can change any of these calculated data by using the manual data entry procedure described in the previous paragraph.

The IDCC cruise performance capability is another good example of how the IDCC is used. The CRUISE PERFORMANCE page (Fig. 5) is accessed by pressing the PERF select key at the top of the IDCC, which brings up a menu page listing the various possible performance computations as subtitles adjacent to the bezel keys. Pressing the appropriate bezel key displays page 1 of the two pages associated with the cruise performance shown in Fig. 5. The first page is used for data entry, and the results of the computation are presented on the second page. The first entry on page 1 is labeled DATA ENTRY; it allows the pilot to designate whether he will enter the data manually (MAN) or automatically, using the available sensors (AUTO). As an example, if the pilot selects AUTO, the altitude is entered based on the barometric altimeter reading; winds and course are taken from the navigator; OAT is taken from the temperature sensor; A/C WT is taken from the DAAS-computed aircraft weight, based on the fuel totalizer function; and power is computed, based on engine rpm and manifold pressure. By toggling DATA ENTRY to MAN, these values are retained and the pilot can manually change any of the entries to meet his particular requirements. The results of the performance computation are presented on page 2 (P2 OF 2), which is accessed by using the IDCC BACK-FWD switch in the lower part of the IDCC.

## 5. SYSTEM ARCHITECTURE

A schematic for PAAS, on which DAAS was based, is shown in Fig. 6. PAAS is a reconfigurable, multiprocessor system organized around a dual bus. Each processor, referred to as a computer processor unit (CPU), consists of a microprocessor, an interrupt controller, a clock, a bus interface module, a read-only memory (ROM), and random access memory (RAM). The system is designed so that each processor is assigned a specific set of tasks. The functional programs reside in the nonvolatile memory. When power is turned on, the bus controller (CPU-1) supervises the loading of the programs into the individual CPU RAM memories. System reliability is achieved by providing a second bus, with bus controller, I/O, and reconfiguration processing unit (CPU-2), to act as a backup for the primary bus, and a spare processor (CPU-7) to act as a backup for the other processor units that do not have direct interface with external sensors (such as CPU-6 and CPU-10). Upon detecting and isolating a failed processor unit other than the bus controllers or CPU-6 and CPU-10, the active bus controller loads the program assigned to the failed processor into the spare processor. Redundancy for CPU-6 and CPU-10 could be provided by multiplexing the respective sensor elements with the spare processor, as was done for the EHSI, CPU-5, or the EADI CPU-9. However, this redundancy is not provided since these functions are not considered to be flight critical; moreover, these particular sensors have a significantly lower reliability than the associated CPU.

A schematic of DAAS is shown in Fig. 7. The DAAS is identical to PAAS, with the exception that it uses a single bus; the sensors and autopilot mode-select panel are interfaced directly with the autopilot, CPU-3; CPU-2 is used only as the radio adapter unit (RAU). These simplifications were made in order to reduce development costs while retaining the capability to evaluate (1) the pilot system interface; (2) the multiprocessor/bus-oriented architectural concept; and (3) certain features of the PAAS reconfiguration concept.

The DAAS uses the IEEE 488 bus. This bus was selected because of the availability of low-cost LSI interface chips and the flexibility provided by the protocol. The computer processor units (other than CPU-2) use the intel 8086, 16-bit microprocessor and have 2 K of 16-bit ROM, and 4 K to 16 K of 16-bit RAM. An Intel 8048, 8-bit microprocessor is used in CPU-2. Electrically erasable PROM (EEPROM) is used for the nonvolatile memory.

## 6. PROGRAM AND FLIGHT-TEST RESULTS

### 6.1 Pilot Evaluation

A primary purpose of the DAAS program was to conduct an operational evaluation of the DAAS concept. The major question being addressed was whether the added capability provided by an integrated avionics system could be effectively used by the pilot. Sixty-four flight demonstrations, in which more than 100 evaluation pilots and observers participated, were conducted to answer this basic question. At the conclusion of each flight the subjects were debriefed and asked to complete a questionnaire. Preliminary results from these tests are contained in Hardy et al. (1982). (A detailed analysis is in preparation.) In summary, a significant majority of the pilots who participated clearly felt that DAAS was representative of the way avionics were evolving and that the added capability could be effectively used to improve the safety and utility of the aircraft. The major concerns that were expressed regarded the training that would be required to utilize the full capability of such systems and the ability to apply this training to the operation of other but similar systems.

### 6.2 Architecture Evaluation

**Modularity:** The PAAS concept is highly modular because of the bus architecture and multiprocessor concept with its shared displays, controls, and sensors. The modularity was tested in DAAS by adding the DABS function. Although the DABS capability was added several months after the final design was completed and fabrication started, it was easily implemented by adding CPU-6 to the system bus, adding a software



module to the IDCC for display and control of the DABS sensor, and adding the address of the DABS function to the bus controller, CPU-1.

**Reliability:** The PAAS is a fail-operational design. Reliability of the PAAS autopilot and navigation functions was computed to be 9,260 hr between loss of function based on a 1-hr mission. A similar analysis on contemporary flight control and navigation systems showed an expected 201 hr between loss of function.

Since DAAS is a one-of-a-kind system, the reliability experience obtained during the tests cannot be extrapolated to PAAS. However, it is worth noting that DAAS was tested in the Ames Cessna 402B for a period of over 6 months, during which time more than 200 flight hours and 500 power-on hours were accumulated. During this period there were a few minor problems traceable to the commercial-grade card-edge connectors (corrected by reseating the cards and reloading the program). There were no failures of DAAS hardware that required replacement of a component. Of the 60 flight demonstrations that were scheduled none was cancelled because of a DAAS hardware or software failure. The PAAS-reconfiguration concept was tested by artificially inserting faults in the CPU-5. Reconfiguration was complete within 1 sec of fault insertion. The spare processor (CPU-7) was successfully loaded and the mission was not affected.

**Maintainability:** The self-test and diagnostic features of PAAS have the potential of isolating failures down to the module level. Because of the fail-operative nature of the system design, a module can be removed for repair, as in contemporary systems, while retaining an operative system. As mentioned above, during the DAAS flights there were no hardware failures that required maintenance; therefore, the maintenance features were not completely tested. However, simulated faults were easily identified, using the available interactive functional test and fault-localization capability.

## 7. CONCLUDING REMARKS

A fully integrated, multiprocessor, advanced avionics system concept, DAAS, was designed, built, and flight tested in a Cessna 402B.

The pilot/system interface was designed to provide a high degree of flexibility and capability while minimizing the operational complexity. Specific design guidelines included (1) commonality of IDCC display format for the various functions; (2) parallel or direct access to all system capabilities, as opposed to sequential access; (3) minimization of the necessity to change display formats during normal flight; and (4) designing DAAS to be a source of information but not a decision maker. Based on the pilot evaluations, these guidelines appear appropriate for the design of avionics for this class of aircraft and mission.

The PAAS architectural concept proved to be highly reliable, maintainable, and modular. State-of-the-art microprocessor technology is easily capable of handling the various functions required in general aviation. The use of a bus architecture allows growth and sharing of limited sensor and display resources between the many subsystems that may be included in a future system. The use of a spare processor for improving reliability by dynamic reconfiguration was successfully demonstrated.

## REFERENCES

- "Demonstration Advanced Avionics System (DAAS) Functional Description" (Honeywell, Inc., and King Radio Corp.; Contract NAS2-10021 Phase 1.) NASA CR-166282, 1982a.
- "Demonstration Advanced Avionics System (DAAS) Final Report" (Honeywell, Inc., and King Radio Corp.; Contract NAS2-10021 Phase 1.) NASA CR-166281, 1982b.
- Denery, D. G., Jackson, C. T., Callas, G. P., Berkstresser, B. K., and Hardy, G. H., "Integrated Avionics for Future General Aviation Aircraft," AIAA Paper 78-1482, Los Angeles, Calif., 1978.
- Denery, D. G., Callas, G. P., Jackson, C. T., Berkstresser, B. K., and Hardy, G. H., "A Demonstration Advanced Avionics System for General Aviation," SAE Paper 790569, Business Aircraft Meeting and Exposition, Century 11, Wichita, Kans., Apr. 1979.
- Hardy, G. H., Callas, G. P., and Denery, D. G., "Preliminary Results from the NASA General Aviation Demonstration Advanced Avionics System Program," The Society of Experimental Test Pilots Association Twenty-Sixth Symposium Proceedings, Beverly Hills, Calif., Sept. 1982.

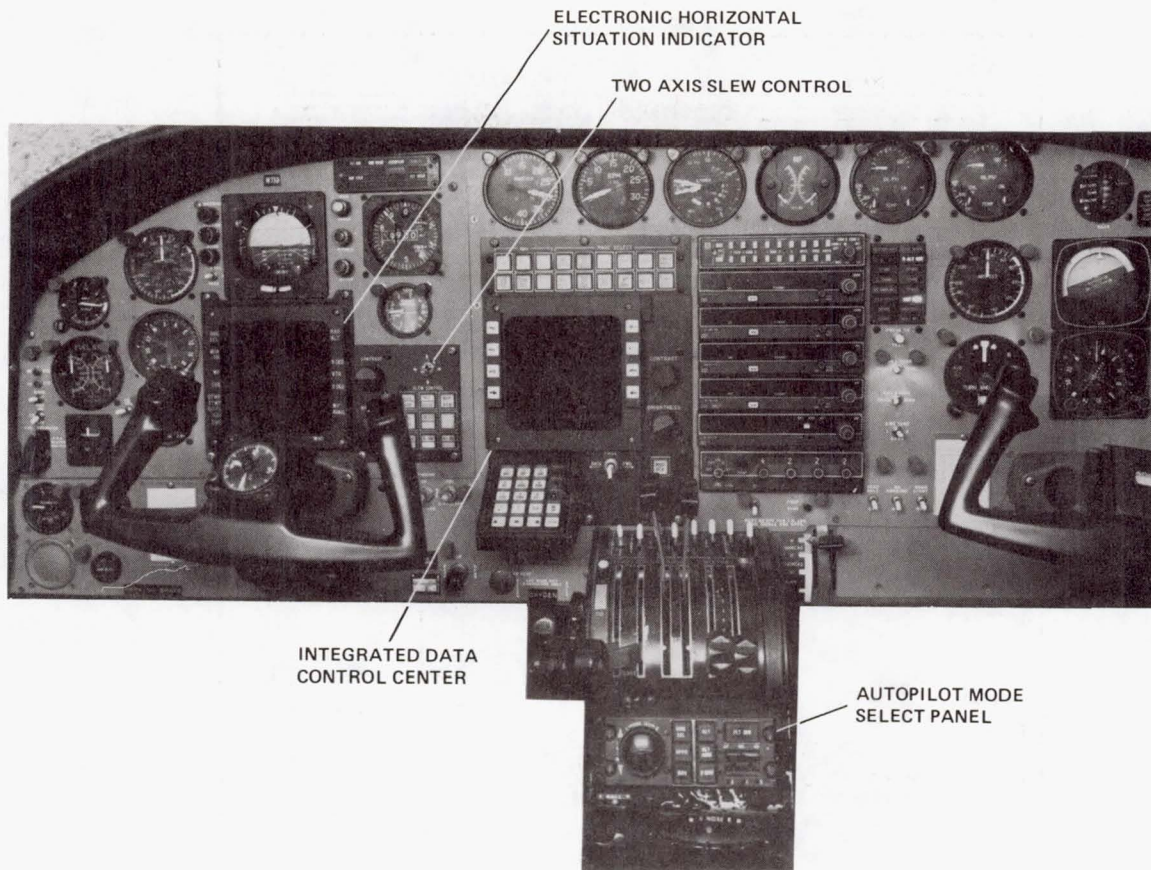


Figure 1. DAAS instrument panel.

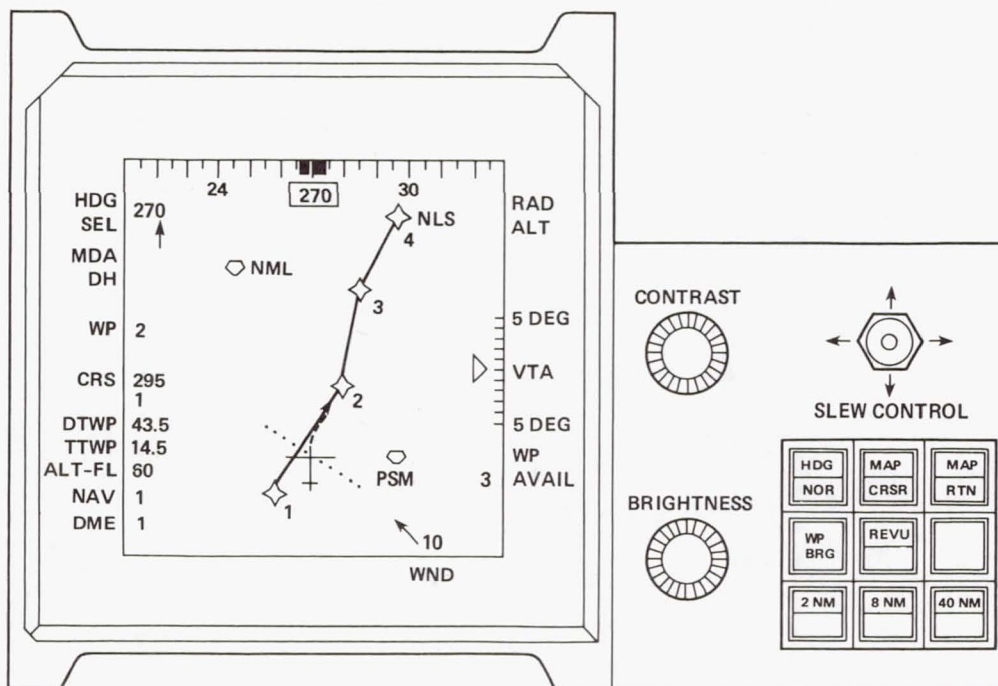


Figure 2. Electronic horizontal situation indicator.



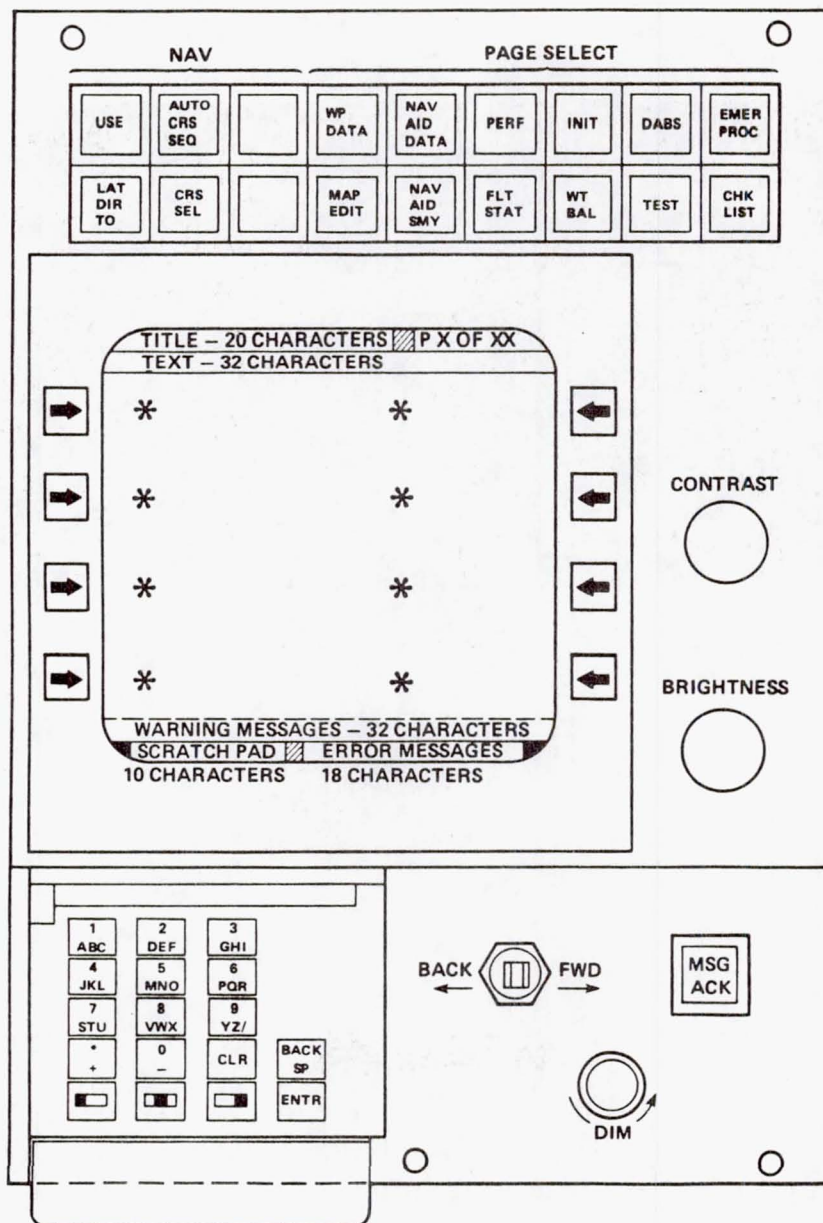


Figure 3. Integrated data control center.

WP DATA		P 1 OF 10	
* WP NO	4	* CRS 1/CRS 2	SEL 236 DEG
			314 DEG
* NAV AID NO/ID	7	* ALT/OFFSET	05500 FT
	SNS		00.0 NM
* FREQ/ELEV	117.30	* MDA OR DH	> NO
	0080 FT		YES
* RAD/DIST	134.5 DEG	* NAV MODE	> RNAV
	014.0 NM		VOR/ILS

Figure 4. Waypoint data page.

CRUISE PERFORMANCE	
* DATA ENTRY	* A/C WT
> MAN	6300 LBS
AUTO	
* ALT/BARO SET	* DIST
00000 FT	000 NM
29.92 IN	
* WIND DIR/SPD	* POWER
000 DEG	00 PCT
000 KTS	
* OAT/COURSE	
15 C	
000 DEG	

(a) P1 OF 2.

CRUISE PERFORMANCE	
1 PWR-PCT .....	00
2 MAP .....	00.0
3 RPM .....	0000
4 FUEL FLO-PPH .....	000
5 NM/LB FUEL .....	0.00
6 TAS-KTS .....	000
7 GS-KTS .....	000
8 DIST-NM .....	000
9 ETE-MIN .....	000
0 FUEL REQD-LBS .....	000

(b) P2 OF 2.

Figure 5. Cruise performance.

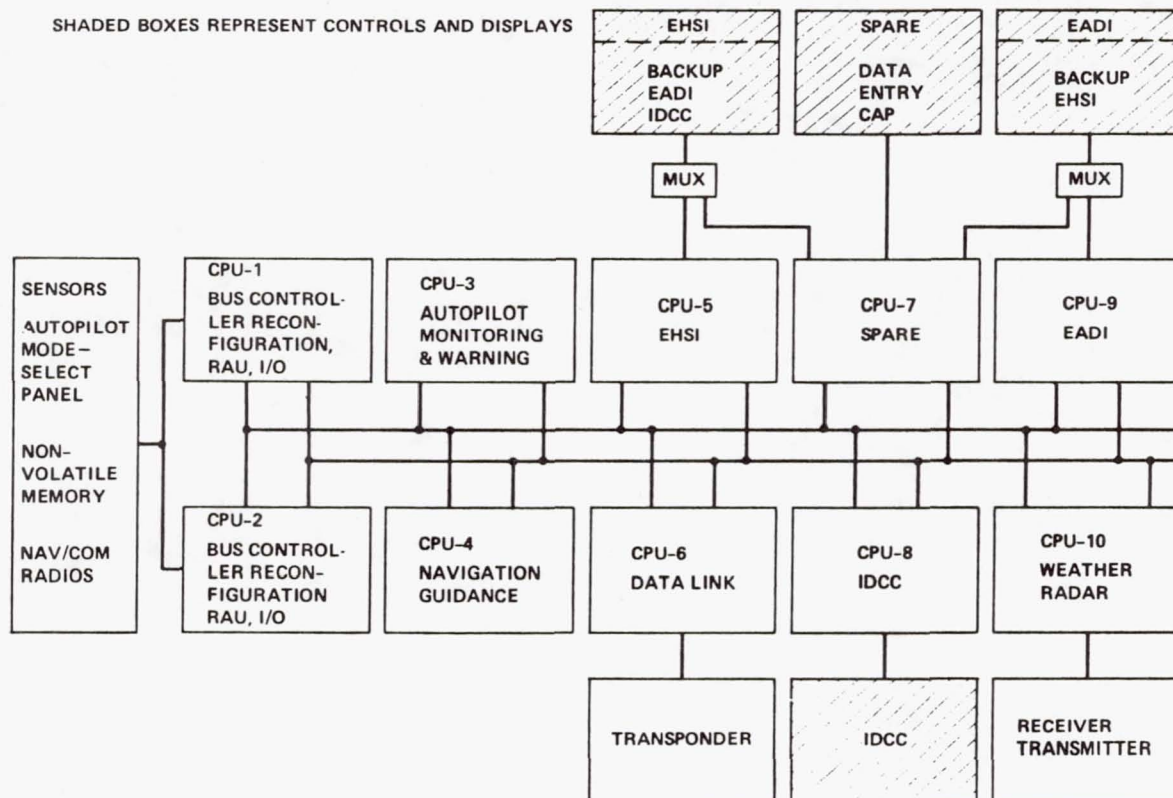


Figure 6. PAAS architecture.



SHADED BOXES REPRESENT CONTROLS AND DISPLAYS

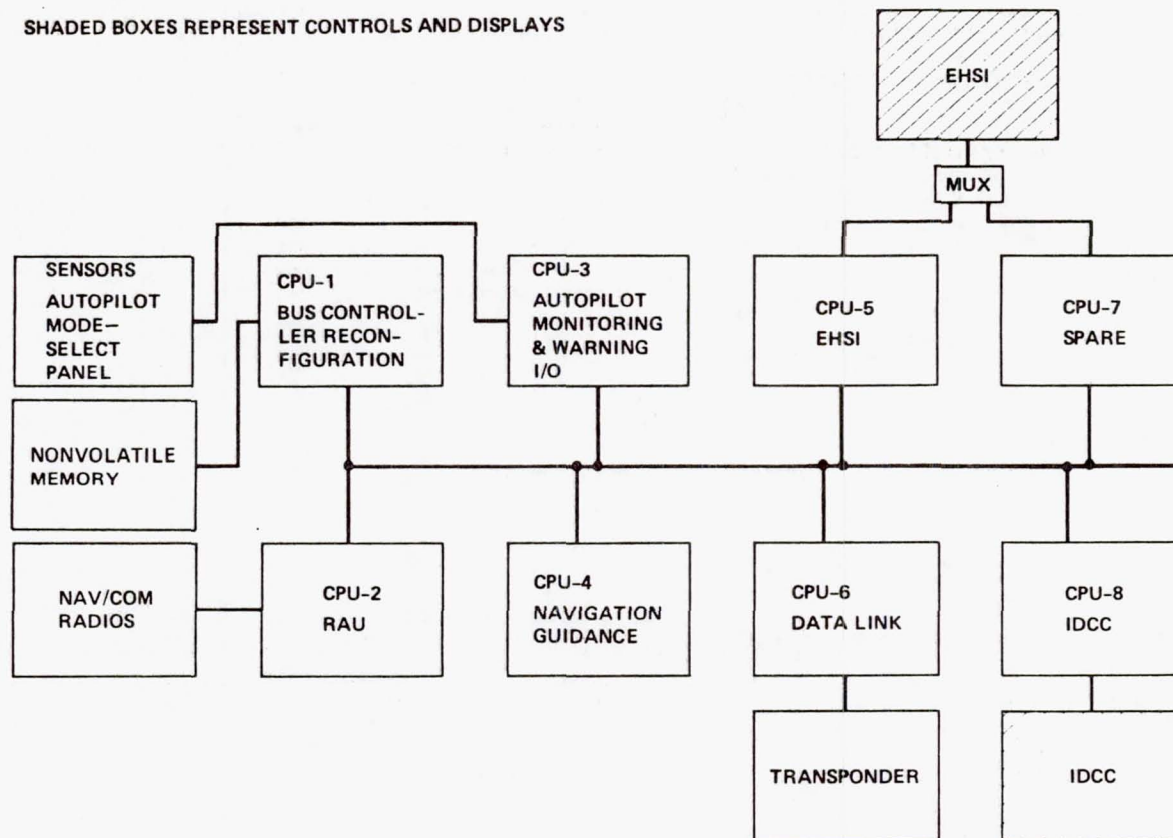


Figure 7. DAAS architecture.

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16. Abstract  Ames Research Center initiated a program in 1975 to provide the critical information required for the design of integrated avionics suitable for general aviation. The program has emphasized the use of data busing, distributed microprocessors, shared electronic displays and data entry devices, and improved functional capability. Design considerations have included cost, reliability, maintainability, and modularity. As a final step, a demonstration advanced avionics system (DAAS) was designed, built, and flight tested in a Cessna 402, twin-engine, general-aviation aircraft. The purpose of this paper is to provide a functional description of the DAAS, including a description of the system architecture, and to briefly review the program and flight-test results.					
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